RESEARCH DEPARTMENT

A COMPARISON BETWEEN BAND I AND BAND III RECEPTION IN THE LONDON AREA

Report No. K-116

(1956/31)

B. Davis

(W. Proctor Wilson)

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SUMMARY

This report presents all relevant data obtained during tests which have recently been carried out by the B.B.C. Research Department on Band III transmissions and gives comparisons between the useful service areas of Band III and Band I transmitters using present techniques.

1. INTRODUCTION.

An appraisal of the useful coverage of a television transmitter requires the assessment of the effect of a large number of factors, some of which vary widely for different receiving installations. In this report an endeavour is made to show the overall effect of most of the relevant factors which determine the quality of the service provided.

Field strength surveys of low power Band III transmitters sited at the existing Band I television stations at Holme Moss and Wenvoe have been completed. Some measurements have also been made of the I.T.A. transmissions from Croydon and some subjective tests of picture quality for various receiving conditions have also been carried out.

2. FIELD STRENGTH COMPARISONS.

The results of the field strength surveys of Band III transmitters recently carried out show that in *general*:

i. The ratio of Band III to Band I field strength is proportional to frequency only when the propagation path is fully optical.

ii. In towns having a mean Band III field strength greater than 0·5–1 mV/m for a transmitter e.r.p. of 100 kW the Band III mean value is usually greater than the corresponding Band I mean value. For towns where the mean Band III field strength is less than this the reverse is the case.

iii. The range of variation of field strength in any area is greater for Band III than Band I and for vertical polarisation the Band III minimum values in towns are, in the average case, approximately 4 dB lower than the corresponding Band I values.

3. RECEIVER AND AERIAL COMPARISONS.

The following conditions may be said to represent those at the average viewer's receiving installation situated in a fringe area:

	Band I Channel 1	Band III Channel 9	Band III/Band I
Effective length of $\frac{\lambda}{2}$ dipole (rel. 1 metre)	+6·6 dB	-6 dB	-12·6 dB
Aerial gain (rel. $\frac{\lambda}{2}$ dipole)	+2·5 dB (H aerial)	+8 dB (6-element Yagi aerial)	+5·5 dB
Feeder loss (50 ft BA3 or PT1)	-1·3 dB	-3 dB	-1·7 dB
Receiver noise factor	6 dB	10 dB	-4 dB
			-12·8 dB

This means that to obtain similar signal/noise ratios on the received pictures for Bands I and III it is necessary to have a Band III field strength 4·36 times that available on Band I, i.e. a 436μV/m picture is equivalent to 100μV/m on Band I.

The effect of ignition or other interference has not been taken into account here but the above conditions will probably be representative of rural districts at the outer edge of the service area.

Observations have been made in the Tunbridge Wells area where the median Band III field strength of the I.T.A. transmitter is 0·5 mV/m and at Kingswood Warren where the field strength is of the order of 20-30 mV/m. In this latter case the signal was attenuated to be equivalent to that obtainable in an area having a field strength of 0·5 mV/m for various values of aerial gain.

In both cases it was found that the ratio of between 4:1 and 5:1 was confirmed. It was found however that different makes of receiver produced pictures which were quite different in appearance for the same signal input level. In these cases subjective opinions about the relative quality differed.

Certain factors combine to give this difference in apparent noise on the picture, the following being principally concerned:

a. *High frequency response.* In the receivers with the better high frequency response noise was the more objectionable.

b. *Colour of tube face and/or filter.* The dark tinted screen tended to make noise more apparent.

c. *Noise factor.* The least sensitive receivers usually have the lowest noise factor.

Receiver noise normally limits the use of maximum sensitivity on Band I. Average figures of maximum sensitivity of various commercial receivers are given below.

Band I	30–40 μV open circuit at input for peak white (12–16 μV/m for above conditions)
Band III	180–220 μV open circuit at input for peak white (200–245 μV/m for above conditions)

4. MULTIPATH INTERFERENCE.

This is much more widespread for Band III than for Band I. (Details of measurements made in the Holme Moss area may be obtained from Research Department Report No. K–111.)

It has been found in practice that even when using highly directional aerials the position of the aerial is very critical. Occasionally, i.e., in some of the worst cases, the best picture is obtained by using one of the reflected signals, although the definition is usually poor.

5. IGNITION INTERFERENCE.

The service area of television transmitters is seriously limited in urban areas by the presence of impulsive interference from various sources, one of the most prevalent being motor vehicle ignition systems.

In order to be able to decide the seriousness of this type of interference on Band III some tests have been recently carried out. It was decided that the most useful form of data would be obtained by subjective comparisons of the differences in the relative strength of the interference on Band I and Band III since much information is available for Band I and the results of practical experience are widely known. Some figures have recently been published[1] for a few particular vehicles but it is doubtful whether these give sufficient information because of the very wide range of levels of interference radiated by different vehicles. The results given in this report were obtained from observations on more than 100 individual vehicles of random type and age.

The site chosen for the experiment was 60 ft (18·4 m) from a main road and the field strength of both Band III and Band I transmissions was 0·75 mV/m at 30 ft (9·2 m) above ground level.

Observations were made simultaneously on the two bands with two similar modern commercial receivers. The receiving aerials (an H aerial for Band I and a three-element Yagi aerial for Band III) were erected on the same mast at 30 ft (9·2 m) above ground level.

Results were noted only on those vehicles which passed the receiving point one at a time so that a direct comparison was made for each particular vehicle. The

maximum degree of interference on both receivers was assessed in terms of one of five grades, these being classified as follows:

i. Not perceptible
ii. Just perceptible
iii. Slightly disturbing
iv. Very disturbing
v. Intolerable.

The percentage of vehicles causing these grades of interference was as shown in Fig. 1.

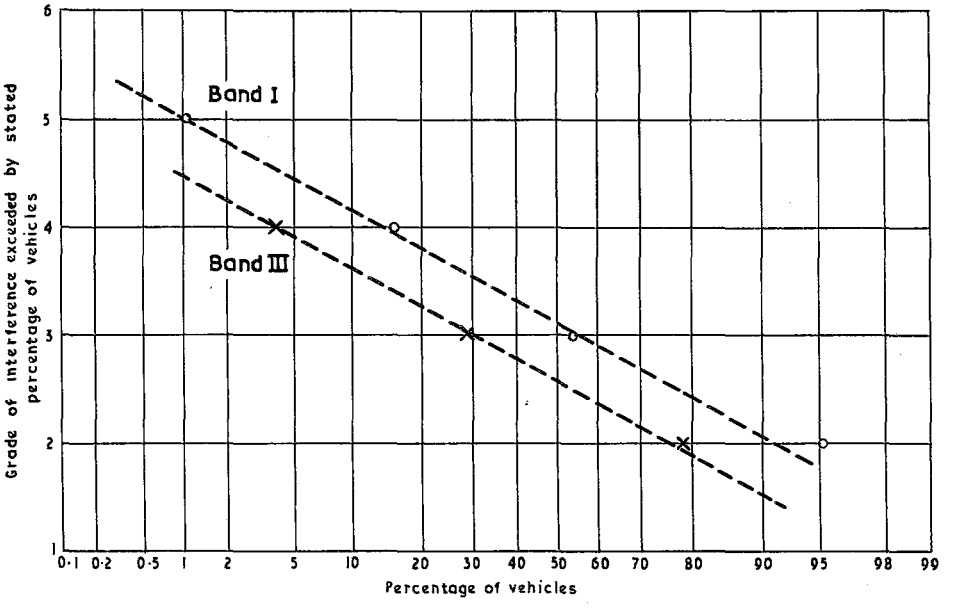


Fig. 1 - Comparison of ignition interference on Band I and Band III
Polarisation - vertical
Receiving aerial 60 ft (18·4 m) from road at 30 ft (9·2 m) a.g.l.
Field strength 750 μV/m at both frequencies

It will be seen that for any given percentage of the total number of vehicles the interference was a half grade less on Band III than Band I but it should be noted that each individual vehicle did not necessarily radiate in this proportion on the two frequency bands.

Direct comparison of the results for individual vehicles showed that:

2% of the vehicles caused interference which was two grades worse on Band III than Band I

4% of the vehicles caused interference which was one grade worse on Band III

50% of the vehicles caused interference which was equally graded

33% of the vehicles caused interference which was one grade worse on Band I

11% of the vehicles caused interference which was two grades worse on Band I than Band III.

Measurements were also made of the distances at which interference became imperceptible for a number of vehicles. The average distance for Band I was 89 yd (82 m) and for Band III 54 yd (49·6 m), the maximum distances being 200 and 120 yd (184 and 110 m) respectively.

6. THE EFFECT OF AIRCRAFT.

The effects of aircraft on television reception are well known but, due to the many variable factors involved, the magnitude of these effects (echoes and flutter) are difficult to predict.

The relevant variables are:

i. Aircraft reflecting properties (which are dependent on size, construction and angle of incidence of the radiation).

ii. Aircraft course, speed and position.

iii. Frequency of the transmission.

iv. Path attenuation of the direct signal relative to that via the aircraft.

v. Transmitting and receiving aerial directional properties.

vi. Receiver characteristics.

vii. Subjective visual interpretation.

To obtain quantitative measurements of most of these factors it is necessary to conduct experiments using controlled aircraft but the object of the tests described here was to obtain comparisons between the overall effect on the average receiver when using frequencies in Band I and Band III and the observations were made on the interference caused by random aircraft.

Simultaneous observations were made of the pictures received on Channel 1 and Channel 9 at a number of sites in the London area using the same equipment as that used for the observations of ignition interference. Some recordings of the variations in field strength were also made.

The results of these observations were as follows:

a. At sites where the direct path attenuation was low (i.e. an optical path) aircraft caused only slight flutter effects on Band I and no flutter was perceptible on Band III.

b. At all the sites the duration of perceptible flutter due to any aircraft was shorter for Band III than Band I.

c. The periods of flutter due to any particular aircraft did not usually occur exactly simultaneously on both frequencies. NOTE: This may be partly due to the difference in location of the transmitter sites.

d. Only very occasionally (at sites which were screened from the transmitter) was the flutter worse on the higher frequency.

e. Echoes from aircraft were usually more noticeable on Band I than Band III.

These results may appear to be contrary to those obtained for multipath interference from static objects where the relative amplitude of the reflected signal is usually greater for Band III than for Band I.

The reasons for this are probably as follows:

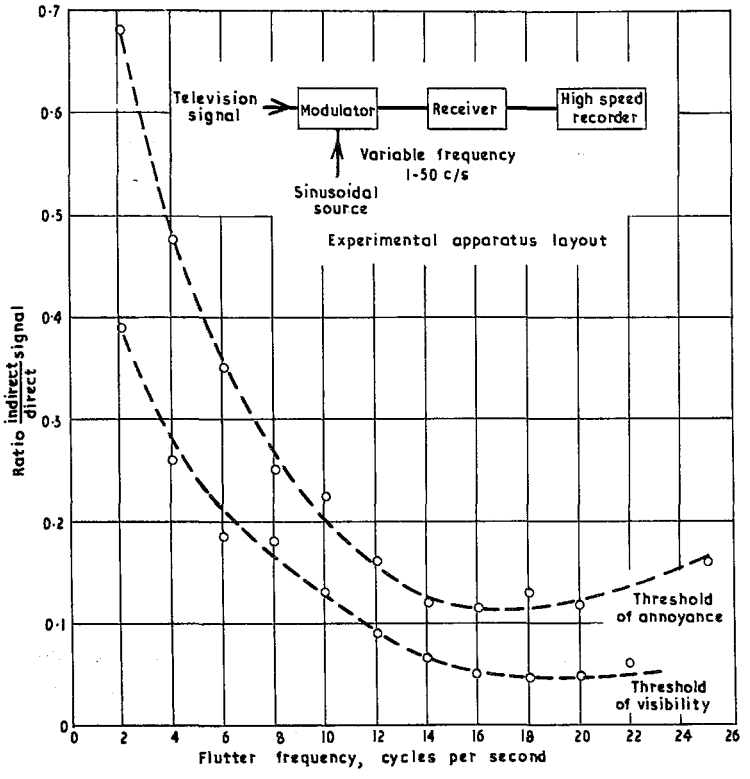


Fig. 2 - Visibility of flutter on television pictures (simulation of aircraft flutter)

Mean curves for two observers

For an aircraft speed of 250 m.p.h. the maximum flutter rate which can be reached is approximately 16-25 c/s for Band I transmission frequencies whereas for Band III it is about four times this value. This maximum rate of flutter is approached when the aircraft is close to the transmitting or receiving terminals and falls to zero when the aircraft is midway between. It has been found in practice[2] that the reflected signal is greatest when the aircraft is close to the receiving terminal.

An experiment was carried out to determine the effect of frequency on subjective visibility of flutter on a television picture. The results are given in Fig. 2 and although these curves are not claimed to be comprehensive, since many factors such as brightness change and adaptation of the eye affect the results, they are considered adequate for this purpose.

It will be seen that the frequency of greatest sensitivity is approximately 17 c/s which is a similar frequency to that obtained on Band I when the aircraft is close to the receiving site and therefore when the amplitude of flutter is greatest. For Band III, however, this frequency is reached and exceeded when the aircraft is much more distant from the receiver and when the aircraft is close to the receiver the flutter is not likely to be perceptible except as modulation "bars". Also, since the flutter on Band III covers a much greater range of frequencies than for Band I for the same change in aircraft position, it follows that the period in which a particular range of flutter frequency is obtained is less for Band III than Band I.

Another factor which will tend to reduce the amount of "flutter" on Band III compared with Band I is the greater directivity of receiving aerials in general use.

7. CONCLUSIONS.

For a viewer having an average receiver with the types of aerial used in present day practice in a fringe area a Band III field strength of between 0·4 and 0·5 mV/m is required to obtain pictures similar to those obtained for a Band I field strength of 100μV/m in the absence of interference, i.e., second class service.

Field strength values to provide the higher grades of service, however, will be similar to those for Band I because of the rather lower level of ignition interference and the greater directivity of Band III receiving aerials in general use.

Multipath interference from static reflecting objects is rather more widespread on Band III than Band I. Aircraft reflections are less troublesome in Band III than in Band I. The probable reasons for this are discussed.

8. REFERENCES.

1. Dilworth, R.A., A.M.I.E.E., "Interference with Television Reception: Some Causes and Cures", Journal of the Television Society, Vol. 8, No. 1, January-March 1956.

2. Research Department Report No. K-067 (1947/24), "The Effect of Aircraft on the Reception of V.H.F. Transmissions in the 45 Mc/s Band",
Research Department Report No. K-067/2 (1951/1), "The Effect of Aircraft on the Reception of V.H.F. Transmissions in the 90 Mc/s Band ".

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